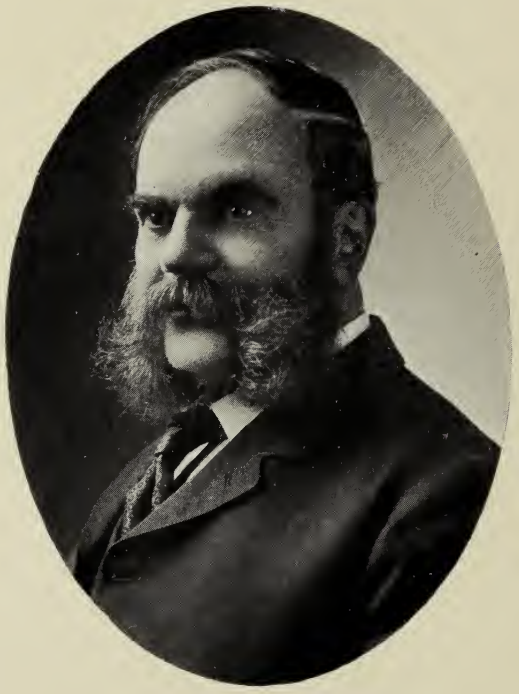
With
Compliments of
The Author.



WILLIAM ROBINSON A.M.; E & M.E.

Original Inventor and Patentee of the Robinson Automatic Electric and Electro-Pneumatic Signal Systems for Railroads,

As now installed by the Union Switch and Signal Company and the Hall Signal Company, under the fraudulent pseudonyms, respectively, of the "WESTINGHOUSE Electro-Pneumatic Block Signal System," and the "HALL Signal System."

History of Automatic Electric and Electrically Controlled Fluid Pressure Signal Systems for Railroads

BY

WILLIAM ROBINSON, A. M.; E. & M. E.

Inventor of the Automatic Systems now in general use on the leading railroads in the United States and Foreign countries

ILLUSTRATED.

ANNOUNCEMENT.

AN ANNOUNCEMENT OF THE NEW ROBINSON ELECTRIC RAILWAY SYSTEM, FOLLOWED BY A BRIEF HISTORY OF AUTOMATIC RAILROAD SIGNALING IN THE UNITED STATES, WILL BE FOUND ON THE FOLLOWING PAGES.

1906.

WILLIAM ROBINSON, 672 PUTNAM AVE., BROOKLYN, N. Y.

1906
CRIST, SCOTT & PARSHALL,
Cooperstown, N. Y.

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PREFACE.

Signal engineers and others have found it almost impossible to get authentic information or to find correct historical data on the subject of Automatic Electric Railroad Signaling in the United States, and it is found that even men high up in the signal companies are equally without authentic information on the subject.

The reason for this anomalous condition is that the heads of these signal companies are systematically supressing the facts of history and putting out the signal systems fraudulently under their own pseudonyms for the purpose of appropriating to themselves credit and reputation belonging not to them but to another.

For the same purpose the technical journals have been flooded with spurious literature and advertisements by these unscrupulous burglars of other men's reputations. To illustrate: the Union Switch and Signal Company, of which George Westinghouse is President, puts out an automatic signal system under the pseudonym of the "Westinghouse Automatic Electro-Pneumatic Block Signal System," although the records show that George Westinghouse never invented an automatic signal system of any kind controlled by moving trains and never contributed anything whatever, as an inventor, to advance the art of such automatic signaling, also that the system put out under his pseudonym, as above, was invented and specifically patented by the author, in foreign countries, more than thirty years ago, all of which will be demonstrated hereinafter.

To further illustrate: The Hall Signal Company, another pirate craft sailing under the black flag in search of annoying reputations which it may destroy with impunity in order to substitute its own tarnished name and fame therefor, is putting out an automatic signal system, invented and patented many years

54089

ago by the author, under the spurious designation of the "Hall Signal System."

In a suit in which the Hall Signal Company was defendant, Counsel for that company, in a most eloquent plea before the Court of Appeals says of this system "Defendant's operation is, in every part and parcel, on every foot of every section, and over every signal, a Robinson operation, pure and simple. * * * Every characteristic Robinson feature is retained. Every signal taken by itself is a pure Robinson signal. The whole taken together is a mere assemblage of Robinson signals." (A more complete quotation is given under the heading. "Federal Courts Decisions.")

It may be here plainly stated that the author is the original inventor and patentee of the automatic electric-electro-pneumatic, and electrically controlled fluid pressure signal system, now in general use on the leading railroads in the United States, and wherever automatic electric signals are used on railroads throughout the world as hereinafter fully demonstrated.

In view of this fact, and the difficulty or impossibility of obtaining authentic information on the subject, elsewhere, and the systematic efforts of interested parties to bury the truth in muck and supplant it by satanic falsehood, engineering friends and others have urged the author to write an authentic history of Automatic Electric Railroad Signaling.

On looking back over the field for thirty years, therefore, he has concluded that as he is better equipped for the work than any one else, the vindication of his own reputation as an epoch making inventor, the verity of outraged history which is being daily perverted by audacious "grafters" of his reputation, desire for accurate knowledge on the subject on the part of tens of thousands of interested railroad and signal engineers, the duty of exposing the thieving jackals and rapacious gray wolves of graft that beset the footsteps of every creator of a valuable invention, and the interests of that great army of honest, able and often oppressed and defrauded inventors on whose work the advance of civilization chiefly depends, in the interest of truth honesty, honor and fair dealing; in the interest of all these he

has deemed it a pressing duty to write this brief history at the present time.

This work is intended as a plain statement of facts, with every essential statement supported by reference to official records or other indisputable evidence, so that any one disposed to investigate may be able to confirm the statements for himself. It does not however pretend to be exhaustive.

Names are plainly used and their owners characterized. This is a painful necessity; but it is pointed out that this work is intended for plain authentic history and therefore sentiment must give way to indisputable demonstrated facts.

The author, however, distinctly disclaims any feeling of personal animosity toward any of the persons named herein. He uses the knife as the surgeon uses it, to eradicate a moral leprosy which is all too prevalent.

A wise man has too much regard for his own equanimity of mind to cherish enmity against anyone.

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ANNOUNCEMENT.

The New Robinson Electric Railway System.

For many years Mr. William Robinson has been working on the baffling problem of producing an Electric Railway System by which the Third Rail may be made safe for running high speed trains through the open country, that is, substituting electric for steam trains. This problem he believes he has solved in a simple, efficient and reliable manner, whether trains are driven by a direct or an alternating current.

What this system will accomplish:

1. The Third Rail, made in sections of any desired length, is normally dead. When a train enters upon a section that section only becomes alive, furnishing working current, and becomes dead again the instant the train leaves the section.

2. When a train enters upon a section it takes control, not only of that section, but also of the section in its rear in such a way that a train entering upon that rear section finds its current cut off and cannot proceed.

3. A train entering upon said rear section not only loses current but has brakes applied with a power proportional to its speed, thus preventing possibly dangerous coasting.

4. A train thus stalled takes possession of the section back of it in the manner above described. Thus each train, whether running or stalled protects itself from rear end collision by automatically keeping the length of a dead block between itself and a following train.

5. **Switches and drawbridges:** The first movement to unlock a switch or drawbridge embodied in a section cuts off the possibility of working current reaching the block located at either end of said section; thus a train approaching from either direction is arrested when a mile more or less from the section embodying

said switch or drawbridge and has brakes applied as described.

6. **Alternating Current:** When the alternating current is used for motive power its potential can be reduced to a much lower voltage than heretofore found possible for this class of work.

7. **Signals:** This system may be used with or without a signal system.

Where the Robinson Closed Rail Circuit System of automatic signals is used, which means practically everywhere that automatic signals are installed, this system may be installed without changing the signals or signal sections. Interference with the correct operation of the signals by the propulsion current is rendered impossible.

The above is intended merely as a foreword. This system will be fully described hereafter at the proper time. The precaution of properly protecting it throughout the world necessarily causes delay in publication. I therefore reserve the right to withhold further information until I deem it prudent to publish it.

THE ROBINSON AUTOMATIC RAILROAD-SIGNAL SYSTEMS.

About 1867 Mr. William Robinson, then a recent graduate from college, entered actively upon the development of an automatic signal system for preventing accidents of various kinds on railroads. His attention was called to the subject by the consideration of certain railroad accidents which had occurred, and for the prevention of which there were no adequate means known.

From this starting point he developed such a system, and in 1869, constructed an elaborate model illustrating the same, which he exhibited at the American Institute Fair in New York city, in 1870.

This system was what is now known in the art as a "wire" or "open circuit" system; that is, there were circuit-instruments in proximity to the track which were actuated by the wheels of a car. The action of the wheels on a lever at one point closed the circuit through a relay, whose magnet was so arranged that the instant it was magnetized it attracted its armature and kept its own circuit closed. The circuit of the magnet which directly actuated or controlled the signal was under control of the relay, which operated to open and close the signal circuit directly.

When the train or car proceeded to the proper point beyond it actuated a reversing lever, thus opening the relay circuit, and reversing the signal.

In the model described the reversing lever operated to open the relay circuit by cutting off the battery therefrom by short circuiting.

This model was in continuous and perfect operation throughout the duration of the fair.

At the close of the fair Mr. Robinson had some of his descriptive circulars left over. These he immediately sent out to railroad companies at random.

One of these circulars at least, was as seed sown in good ground. It elicited an immediate response from Mr. William A. Baldwin, General Supt. of the Philadelphia and Erie Railroad, with the result that Mr. Baldwin, who was an old telegraph operator and a very able and progressive railroad man, on looking into the system was so impressed with its practicability and importance that he at once arranged with Mr. Robinson to make an installation of the system on his road. This was in 1870.

At that time Mr. Theodore N. Ely, now Chief of Motive Power of the Pennsylvania Railroad, was Assistant Superintendent of the Phila. & Erie R. R., and, under direction of Mr. Baldwin, furnished Mr. Robinson with all the facilities and material necessary for prosecuting the work of installation.

This installation was made at Kinzua, Pa., and after a little experimenting was soon in perfect working order, performing all claimed for it, and considered satisfactory by the railroad company.

This was a normally open-circuit wire system, however, controlled by track levers, as above described, in connection with the model.

As soon as it was found to be working perfectly and accomplishing all claimed for it, Mr. Robinson, who aims to be his own most severe critic of his own work, entered systematically into a deeper study of the system, from the standpoint of a railroad man, with a view of finding the weak points in it, if any existed.

He soon discovered the following serious defects, which are inherent in all normally open circuit or wire systems of automatic signaling, without exception.

Such systems are extremely limited in their functions, and *may, under certain circumstances*, show a SAFETY signal when the danger actually exists which they are designed to avert, as in the following cases:

First: A train enters regularly upon the section and sets the signal at danger; the train breaks in two, the forward part passes off the section, reverses the signal and shows ALL CLEAR behind that portion of the train remaining on the section; and

a following train, lured on by the false signal ALL CLEAR dashes into the stalled portion of the preceding train left standing on the section. This is extremely liable to happen on sharp curves and grades, where breaks are not of uncommon occurrence.

Second: A train may enter within the section from the opposite end or from a siding thus blocking the track, while the signal, not having been affected, shows ALL CLEAR as before, a false signal again.

Third: If a line wire break or other connection be interfered with accidentally or maliciously, or the battery fail from any cause, the signal will invariably show ALL CLEAR, under every train passing over the section a false signal again.

Mr. Robinson at this early date recognized the above serious objections as inseparable from open circuit system, of signaling, apparently, before these defects were recognized by any one else, and at once entered upon the solution of the problem presented, of eliminating these objections by producing a signal system which would meet all the requirements of safe and efficient railroading.

He reasoned that to accomplish this result every car and every pair of wheels in the train must have controlling power over the signal throughout every inch of the block section, and secondly,

The signal should go to danger by gravity, the electric current being used to hold it at safety.

Could these two results be accomplished? Could the rails be used in any way to carry the primary current in a reliable manner? Manifestly not by any open circuit means, for the reason that sections of rails of even moderate length, on open circuit, would form a good ground, especially in damp or wet weather, thus keeping the circuit closed continuously and preventing any operation of any kind.

He at once cast aside this open rail circuit idea as fruitless, and having previously, in 1869-70, used the short circuiting principle in his model, as above stated, he concluded that this principle presented the only possible solution of the problem.

He then made drawings of the closed rail circuit system sub-

stantially as it is used today, and in 1871 applied for a patent thereon, broadly covering the closed rail circuit system.

In 1872 he made an exhibition of this system at the State Fair, held at Erie, Pa. Here he placed a large gong on the end of one of the buildings, on the outside, and inside he had a track made in sections placed in a long water tank made for the purpose. The track was covered several inches deep with water and the running gear of the car model was similarly immersed.

The system was connected on the short circuit principle through the rails. Wires connected the gong with the back contact of the track relay.

The water had no perceptible effect on the operation of the apparatus, and when the car was run on the signal section it short circuited the current from the relay, which, releasing its armature, closed circuit through its back contact and thus through the magnet of the gong circuit, thus setting the gong ringing loud enough to be heard all over the grounds.

On running the car off the section the current returned to the relay energizing the same and thus opening the gong circuit at the back contact of the relay, thereby causing the gong to cease ringing.

The whole operation was perfect, demonstrating the successful operation of the closed circuit system, and attracted great crowds of people as well as the marked attention of practical railroad men.

It will be understood, of course, that the local circuit may be normally open as above described and used, or normally closed as now commonly used, according to the exigencies or requirements, or preferences of the parties using the same, and when desired a visual signal may be substituted for the audible signal above described. These are all minor details not involving separate invention.

Mr. Robinson had previously explained the new closed rail circuit system to Mr. Baldwin who was greatly interested and expressed his confidence in it and requested Mr. Robinson to install the system at Kinzua, where he had already installed the open circuit wire system.

As all the signal apparatus, relays, batteries, office switches

and overlapping devices were already in operation there it took but a short time to convert this open circuit system into a closed rail circuit system.

The first experiments proved conclusively that the system would work. The track however was in a fearfully unsuitable condition for the purpose. The light rails were fished together by a four foot wooden bar on the outside, and a twelve inch fish plate on the inside. There were two holes through the iron fish plate, allowing one bolt for each rail and four holes through the wooden bar, two for each rail. However, with a little care we managed to get the current working through the whole length of the section about a mile and a quarter in length.

It was evident however that on such a section as this a rail bond of some kind would be necessary for reliable, continuous service, and here, at this time, in 1872 Mr. Robinson conceived the invention of the bond wire method of electrically connecting the rails, now in universal use, or its equivalent. on every electric railway, throughout the world, using the rails for a return.

Fig. 1.

Robinson's Closed Rail Circuit System.

Philadelphia & Erie Railroad, 1872.

As it had been determined to lay new rails at Kinzua another installation of the closed rail circuit system was ordered and

immediately made at Irvineton, Pa. This signal is illustrated in Figure 1.

It will be observed that the above installation, like that at Kinzua, not only displays a visual block signal, but also operates in connection therewith a loud gong which has been easily heard at a distance of a half mile, and was really heard by passengers in trains passing, with closed windows. An engineer could not possibly pass without hearing it.

A wire is seen at the upper part of the signal box, running out to the right. This is an overlapping signal wire.

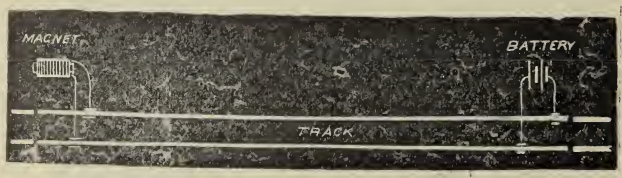
A tell-tale bell was also placed in the station, indicating the actual position of the signal, and also a manual switch, whereby the agent could at any time cut off or short circuit the track battery and expose the danger signal against a train and instantly receive a return signal when the danger signal was actually exposed.

The Irvineton installation worked perfectly from the first never failing. The locomotive engineers were delighted with it and soon gave it the name of "The old reliable."

We will now describe

THE ROBINSON CLOSED RAIL CIRCUIT.

Fig. 2.



Wm. Robinson 1871, Patented in France Feb'y 29, 1872 and United States August 20th, 1872 Reissued July 7th, 1874. No. 5958.

The Robinson closed rail circuit, which now forms the basis, according to the best information, of every efficient automatic electric, electro-pneumatic and electrically controlled fluid pressure system throughout the world, is illustrated in its simplest form, in figure 2.

This figure shows the railroad track divided into sections, a mile more or less in length, the section rails being insulated from adjacent sections. A light battery has its terminals connected to the opposite rails at one end of the section and at the other end a relay magnet has its terminals connected to the opposite rails. Thus the current passes through the whole length of the section, keeping the relay on continuously closed circuit and magnetized as its normal condition. The relay thus keeps the secondary circuit, which directly controls the signal, normally closed, whereby the signal is normally held in a position indicating safety.

When a train enters upon the section the wheels and axles, connecting the opposite rails thereof, short circuit the current from the relay, which instantly releases its armature, thus opening the signal circuit. The signal is then instantly thrown to the danger position by means of a counterbalance.

The signal may be of the enclosed disk type, electro-mechanical, electro-pneumatic, electrically controlled gas, or of any other kind. The Robinson patented system is broad, basic and a generic creation; it is not limited to any specific construction or arrangement of signal but covers all kinds. An automatic signal system by whomsoever installed, using the closed rail circuit, is the Robinson system, and no company or individual has any right to attach any other individual name or designation than that of Robinson to such system in a manner indicating that the system is the invention of any other party than Robinson. Such appropriation of Robinson's credit and reputation as a creative and generic inventor, and original discoverer and applier of a new and previously unknown principle of immense importance and value, is undoubtedly actionable.

In expounding the early history of the art of automatic signaling the following photographic reproductions from some of Robinson's early circulars and patents, will be of interest.

The following sections on Curve, Tunnel, Station, Switch and Draw-Bridge Signals are a photographic reproduction from a circular issued by Mr. Robinson in 1870:

CURVE AND TUNNEL SIGNALS.

A train approaching a curve will throw up a red signal around the curve as a warning to trains from the opposite direction, and will also exhibit a signal in its rear. Thus, collisions from front or rear are guarded against. These signals may be used throughout the whole extent of a road.

In entering a tunnel a train will exhibit a signal at the other end to indicate its entry, and when it gets through it will lower the signal and ring a bell at the opposite end to indicate its exit.

STATION SIGNALS.

A train when it leaves a station, and at various points as it passes, will indicate to the stations along the line, its Location, Direction, Rapidity and Length. Thus all necessary information regarding moving trains will be automatically announced every few minutes at the stations.

SWITCH AND DRAW-BRIDGE SIGNALS.

If a switch or draw-bridge is misplaced an approaching train will set an alarm ringing at the station and will also exhibit a red signal ahead of the train as a warning to the engineer that the switch is misplaced.

The following heading and sections are photographic reproductions of parts of a circular issued by Mr. Robinson at the time of its date, "September, 1872."

It will be observed that certain of these sections are the same as above reproduced from the circular of 1870.

It will be noted also that the description of the system begun after the heading is not here completed, for the reason that a full description is found elsewhere in this history.

ROBINSON'S IMPROVED SYSTEMS

OF

ELECTRIC RAILWAY SIGNALS

For Switches, Draw-bridges, Crossings, Curves, Cuts, and Tunnels; also, to indicate the Location, Direction, Rapidity, and Length of Trains.

IMPORTANT IMPROVEMENTS.---ELECTRIC SIGNALING WITHOUT TRACK INSTRUMENTS, OR LINE WIRES.

THE NEW SYSTEM.

The operation of this system is as follows: A railroad track is divided into sections of any desired length, say one mile, more or less, by separating the abutting rails from metallic contact with the adjacent sections, but preserving metallic continuity throughout the length of the section. The insulation of the abutting rails is accomplished

CURVE AND TUNNEL SIGNALS.

A train approaching a curve throws up a red signal around the curve, as a warning to trains from the opposite direction, and also exhibits a signal in its rear. Thus, collisions from front or rear are guarded against. These signals may be used throughout the whole extent of a road.

In entering a tunnel a train exhibits a signal at the other end to indicate its entry, and when it gets through it exhibits a signal at the opposite end to indicate its exit.

STATION SIGNALS.

A train when it leaves a station, and at various points as it passes, indicates to the stations along the line, its Location, Direction, Rapidity, and Length. Thus all necessary information regarding moving trains is automatically announced every few minutes at the stations.

The batteries for operating the signals will last for months without attention, and one man can readily attend to all the signals and batteries throughout the whole extent of a road.

In all cases, where practicable, the signal wire should be carried through the coils of a bell-magnet in the nearest office. By this means the operator is informed when the battery power is decreasing, and warned that it requires renewing.

Office connections can be made, when desired, so that the signals may be operated by a telegraph key from the office, as well as by passing trains.

The signal wires may be tapped at intervals all along the line, and led into small cast iron boxes placed conveniently on the telegraph poles. Conductors of all trains, furnished with keys to these boxes, can, in case of special accident, go to the nearest box, touch a key within the same, and thus set danger signals at some distance in front and rear of their trains. The telegraph keys in these boxes not only set the danger signals as described, but they also place the said signals, for the time being, entirely out of control of moving trains.

THE CLOSED CIRCUIT.

The new system, as described, with closed circuit, is the best ever devised for "block-signaling," since the failure of the battery through neglect or otherwise, cannot possibly be productive of disastrous results to the train, however implicitly the signals may be relied on.

From the French of Feb. 1872 [*Translation*].

88th claim. "Connecting a battery **B5**, and a magnet **M5** with the rails *a9*, *b9*, of a section of railroad track **C5** in such a manner that when said rails are joined by a metallic bridge, the electric current will be diverted from the magnet **M5**, but so that when said bridging device is removed from said section **C5** the electric current will be free to pass through and charge the magnet **M5**."

93d. "A signal or signals audible or visual in combination with the battery **B5** and the rails of a railroad track, the whole being arranged to actuate the signal or signals, substantially as described."

WILLIAM ROBINSON.

ST. PETERSBURG, Clarion County, Pa., September, 1872.

It will be observed that some of the foregoing sections refer to the open circuit system, some specifically to the closed circuit system and some are applicable to either or both.

The following is a photographic reproduction of a postal card issued and distributed broadcast by Mr. Robinson at the time of its date, "May 1873." It needs no comments.

ROBINSON'S
WIRELESS ELECTRIC SIGNALS,

THE SIMPLEST, CHEAPEST, and

Only Absolutely SAFE Electric Signals in Existence,

NOW IN SUCCESSFUL OPERATION ON THE

BALTIMORE AND OHIO,
PHILA., WILMINGTON & BALTIMORE,
PHILADELPHIA AND ERIE,

AND OTHER RAIL ROADS.

They work as AUTOMATIC BLOCKS with tell-tale alarms, OFFICE, STATION, ROAD CROSSING and SWITCH SIGNALS, and BROKEN RAIL DETECTORS. These signals have worked uninterruptedly through last winter regardless of rain, snow, slush or sunshine.

Descriptive circulars on application.

MAY 1873. **WM. ROBINSON, St. Petersburg, Pa.**

The following cut, Figure 3, is a photographic reproduction from an illustration on a circular dated "January, 1874" and issued by Mr. Robinson at that time.

Fig. 3.

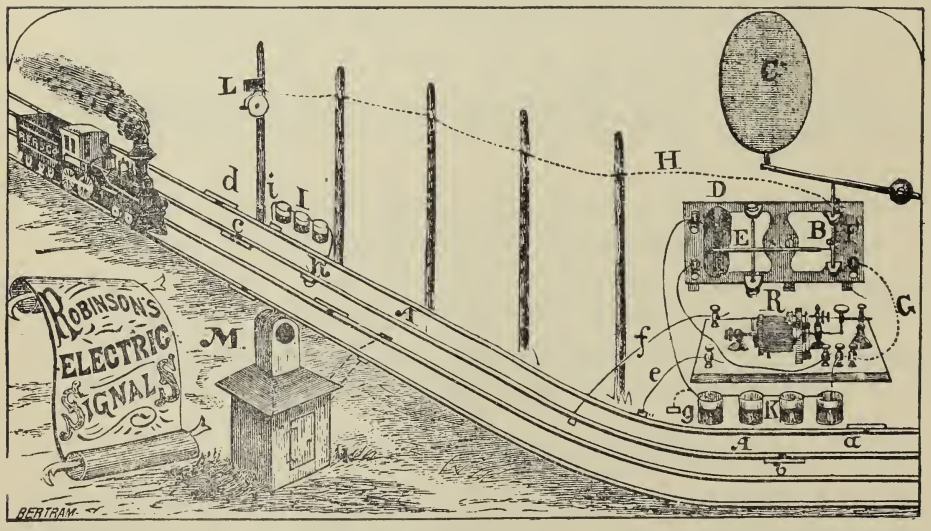


Illustration from Robinson's Circular of "January, 1874," showing the Closed Rail Circuit, Relay and Overlapping System.

It is pointed out that the above illustration of Jan'y, 1874, shows the Robinson closed track circuit, as heretofore described. the relay R and the track battery I forming a part thereof, the signal actuating magnet E, the signal C operated thereby, the circuit wires of said magnet E connected to, and controlled by, the relay R, and the overlapping or distant signal L, with its circuit H controlled absolutely by the position of the signal C, the whole showing a complete closed track circuit overlapping system, with home and distant signals.

The following sections are from this circular of January, 1874:

"When it is desired to operate a secondary signal thrown forward or back of the primary, a line wire H is used, attached to the primary signal C in such a way that the secondary signal cannot possibly operate unless the primary signal C is first exposed, thus closing circuit on the wire H. The primary signal battery K is used also to operate the secondary signal."

"To set the signal from an intermediate station a wire from each rail of the section A is run into the station. When these wires are connected by a key, the current from the battery I is placed on short circuit, and the signal exposed as before." (See fig. 7.)

"The following functions may be embraced in the signals of a single section. BLOCK SIGNALING, both automatic and manipulated, SWITCH, DRAWBRIDGE, ROAD-CROSSING, and STATION-APPROACH SIGNALING, and BROKEN RAIL DETECTING."

"In this system it will be observed that, since the signal is exposed mechanically, any tampering with the rails or connections, or failure of the battery, will invariably result in exposing the signal; any error therefore which may occur from any cause will be in behalf of safety. *It is impossible to show safety when the danger exists which the signal is designed to avert.*"

During the early seventies Mr. Robinson made other closed rail circuit installations on the Philadelphia & Erie and other railroads in Pennsylvania and Maryland.

Visit of the Pennsylvania R. R. Officials.

On October 24, 1873, a special inspection train of the Pennsylvania Railroad passed over the Phila & Erie Railroad, westward. The Penna R. R. officials aboard were: Mr. A. J. Cassatt, at that time General Manager, Mr. Gardner, General Supt., Mr. Lewis, Controller, Mr. Robert Pitcairn, Supt. W. D., and Mr. Frank Thomson, Supt. M. P

Mr. Wm. A. Baldwin, Gen. Supt. of the P. & E. road was of the party, and Mr. Robinson joined the party on the latter road, and continued with it through to Erie, which was reached in the evening.

Stops were made at Ridgway on the Middle Division and at Irvineton on the Western Division to examine the Robinson closed circuit rail system of signals which were in full operation at those points. A thorough examination and various tests were made to all of which the signals responded promptly and perfectly.

I find in my possession a letter which I wrote to my brother on Oct. 25, 1873, the day after the above trip, giving some account of it.

While it is a private letter from one brother to another, without any thought of its being preserved even, I do not think there is any impropriety in giving the following brief interesting extracts from it, at this distance of time:

"Mr. Baldwin could not say enough in favor of the signals" * * * "Of course I remained in the background, except, as to giving explanations. After a while Cassatt, Pitcairn and Thomson got into a discussion of the battery and other points, and called me into the ring to enter into the discussion, and it was quite animated for some time. Pitcairn proceeded to give his ideal of what a signal should be, and Mr. Baldwin and the rest proceeded to show him that this then, was exactly his ideal."

"Mr. Gardner, after learning *modus operandi* from diagrams &c. proceeded to lay down the law to the rest, demonstrating how they would have 'prevented those accidents.' "

"They were all very much pleased with the signals but their operation seemed such a surprise that I judge it will take them

several days to think over and realize the actual operation and importance of the thing."

It seemed to be the understanding after this inspection that the P. R. R. officials would instal this Robinson system on the Pennsylvania R. R. main line. I called on the proper officials several times afterwards—was always received courteously and had fair promises of introduction. Finally these promises were kept, and the Robinson automatic system was introduced on the Pennsylvania road,—a dozen or fifteen years afterwards, and after the control of the system had passed out of Robinson's hands.

ROBINSON'S WORK IN NEW ENGLAND.

In December, 1875, Mr. Robinson went to Boston and took up his residence there.

In January, 1876, he made an installation of his closed rail circuit system between Elm Street and North Avenue, West Somerville, on a branch of the Boston and Lowell Railroad. This installation worked perfectly from the beginning.

The Emperor of Brazil Examines the Robinson Signal System.

In June, 1876, His Imperial Majesty, Dom Pedro II, Emperor of Brazil being then in Boston, graciously accepted an invitation from Mr. Robinson to examine his Wireless Signal System in operation on the Boston & Lowell Railroad. Accordingly, on June 14, they proceeded together by special train to West Somerville for the purpose.

The following is an account of the visit, from the Boston Post of June 15, 1876:

"DOM PEDRO II.

"His Majesty Witnesses the Operations of Railroad Signals.

"Though the visit of His Majesty, the Emperor of Brazil, to this city has been a brief one, yet it is not hazardous to say that no other crowned head or representative of royalty who has ever appeared in Boston has more closely inspected the places where centre arts, sciences and manufactures than he.

In compliance with an invitation, the Dom proceeded yesterday morning to witness the workings of Robinson's Wireless Signal System, now in operation on a portion of the Lowell Railroad. The Emperor and several members of his suite took passage on board a special train on the Lowell Railroad soon after 8 o'clock yesterday morning and arrived at the West Somerville station about 8:30, where they were met by Professor Robinson, who at once began to explain to the royal party his system. At Elm street a large visual signal is placed which is controlled by the current from a single cell of a battery connected with the rail sections at North Avenue, no line wires whatever being used. While the Emperor watched the signal at Elm Street trains were run over the whole length of the signal section in both directions. As soon as the train entered upon the section at either end the signal, without a moment's delay, showed the track "blocked," and when the train passed off the section it instantly changed the signal to "all clear." Then a rail was torn up, and almost instantly thereafter the signal denoted "danger" and remained so until the rail was restored and properly coupled up, when it as quickly changed to "all right." Mr. Robinson gave various other demonstrations illustrating the working of the system. To all the tests the signal instantly responded. His Majesy was much interested, and entered into a somewhat lengthy discussion with Professor Robinson in regard to the operations which he had witnessed. The Emperor's questions displayed profound scientific knowledge, and he fully comprehended the system. At the conclusion of the experiment Dom Pedro thanked Professor Robinson for his kindness in explaining and illustrating his system, and invited him to communicate with the Brazilian Government with a view to introducing the system in Brazil. On the return of the party to the Lowell depot in Boston, the Emperor was received with great applause, which he politely acknowledged by waving his hat."

It will be interesting to note that on June 14, 1876, the day the Emperor inspected the Robinson Signal System at West Somerville, the battery had been in operation exactly 180 days without any attention whatever except that on two occasions a

little water had been added to make up for evaporation, the signal working perfectly all that time and the battery with full strength.

The following is from a report on the above signal by the Station Agent at Elm St., dated June 2, 1877, eighteen months after it had been installed.

"Robinson's Electric Signal at this place has been working uninterruptedly since it was first put in operation. * * * The signal is entirely reliable."

The above signal continued to work perfectly for a number of years until the signal post, which was of wood, rotted down.

The signal mechanism used on the Robinson signal at Elm street was of the electro-mechanical type.

Figure 4 is a half tone of the identical signal mechanism in operation there when the Emperor of Brazil examined the system with Mr. Robinson, on June 14, 1876.

Fig. 4.

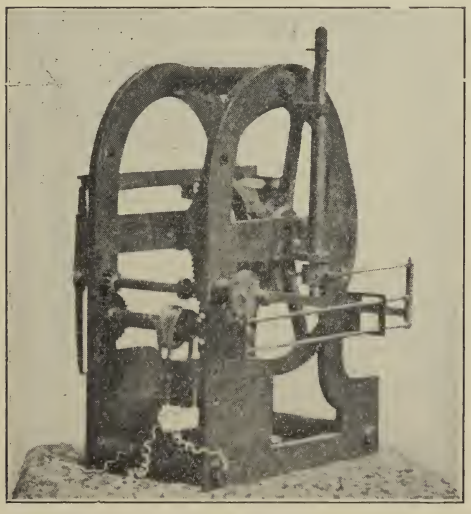
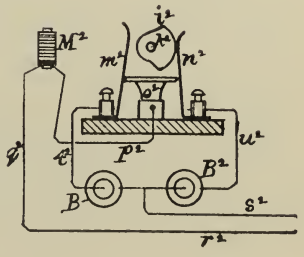


Fig. 4a.



Robinson's Electro Mechanical Signal in Operation at West Somerville when Inspected by the Emperor of Brazil in 1876.

It is pointed out that the above signal mechanism Fig 4, shows a battery or pole changing attachment which is more

clearly shown in Fig 4a, reproduced from Robinson's British patent No. 3479 of Aug. 29, 1879.

In this device the movement of the cam i^2 not only changes the battery but changes the polarity through the magnet M^2 which may be placed anywhere and used for any purpose.

A special device for the same purpose was used not only in connection with the relay on the West Somerville signal, but on many others installed by Mr. Robinson.

This battery and pole changing device is more fully described in Robinson's U. S. patent, August 25, 1874, No. 154,520, Automatic Commutator; Application filed July 18, 1873.

The following extract therefrom, and claim, may be interesting:

"It will be observed also, that while the actual change of battery may be caused to take place when the magnet attracts its armature, yet I prefer to arrange it so that no change of connections shall take place when the armature is attracted, the actual change taking place only during the reverse movement of the armature, caused by the retractile force of the spring. Furthermore, when desired, the batteries may be so connected in circuit that reverse currents shall be passed through the magnets every time the batteries are changed."

Claim 2. "In combination with the electro-magnetic commutator having the described circuit connections, the rail sections $A'A^*$, the one closing the circuit through the commutator, and thereby determining the battery to be connected to the other rail section, substantially as and for the purposes set forth."

It must be admitted that there does not seem to be a very long step between the disclosures of this patent and the present method of operating a distant signal by reversing current through a rail section.

It will be observed that in this patent one rail is used as a return for a plurality of batteries connected to independent opposite rail sections.

In an autograph letter addressed to the author by Professor Henry, Sec'y. of the Smithsonian Institution, under date of Oct. 14, 1875, the Professor discusses Robinson's peculiar method of using batteries in signaling by which he obtained

the above wonderful durability of 180 days or more without renewal, and pronounced the results obtained "very remarkable." His discussion of the subject is somewhat suggestive of the principles of the storage battery.

Switches.

In 1876, 7 and 8 Mr. Robinson made a number of installations on the Boston and Providence, Old Colony and the Boston, Lowell and Nashua Railroads.

On the latter road, at the Wilmington Junction, he equipped two parallel sections of the double track, including six switches in this short space, five of them connected with one of the blocks. These sections were arranged as regular closed circuit blocks, operative under the moving trains. The switches were also connected up in such a way that every switch had to be closed and locked for the main line or the danger signal would be exposed against approaching trains. This installation was made in 1876.

The switch connection applied to these switches is shown in Fig. 5 and a general plan of the same is illustrated in Fig. 6. Both of these figures are reproductions from Robinson's aforesaid British patent of 1879.

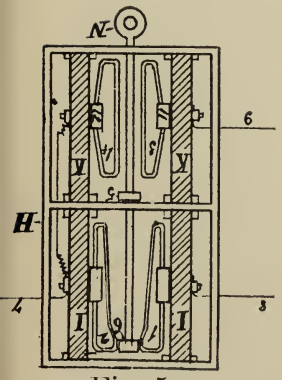


Fig. 5.

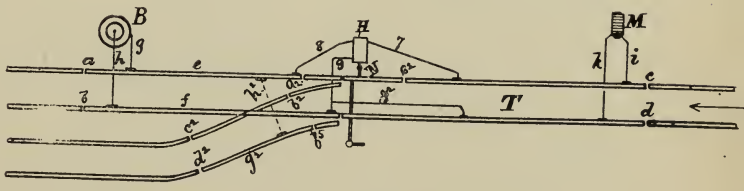


Fig. 6.

It will be obseved that when the switch is on the main line the wires 7, 8 are connected by the plug 6 on the switch connection, thus completing a working circuit through the rails

and around the switch, but when the switch is placed for a siding the wires 7 and 9 are connected by the plug 5, thus short circuiting the current from the magnet M, thus producing the same effect as would the presence of a train on the section. It is always better to short circuit the current rather than trust to the mere opening of circuit since short circuiting is sure to produce instantaneous results.

It will be observed however that in the above case the movement of the switch connection both opens the rail circuit and short circuits the current from the relay.

It may be here stated that Mr. Robinson equipped three switches in one closed circuit block, in the manner described above, on the Philadelphia and Erie Railroad in 1873.

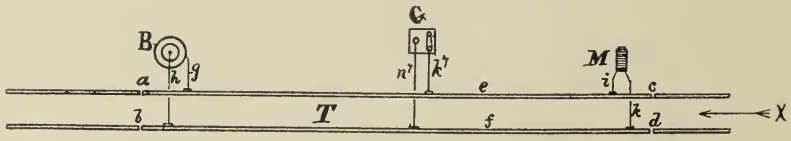


Fig. 7.

Fig. 7, from Robinson's English Patent of 1879, aforesaid, shows the switch G arranged to operate the signal by hand from an office, station or telegraph post by the roadside, as heretofore described.

Drawbridges.

About the time he made the Wilmington installations above described Mr. Robinson made an installation of his system also on the Old Colony Rail Road, in which one block signal section at Somerset included a drawbridge. He included the track rails of the drawbridge in the track circuit in such a way that the withdrawing or loosening of any one of the bridge lock-bolts would display the danger signal, which remained exposed until the bridge and its lock-bolts were all restored to their normal condition insuring safety.

Tunnels.

Long wet tunnels present peculiar difficulties to the reliable operation of the rail circuit; and yet these difficulties are readily overcome by including one or more additional relays in the signal section, as shown in Fig. 8, which illustrates the application of the Robinson track circuit system as applied to the Tehuantepec Tunnel in California.

Mr. Robinson forwarded the signals and necessary instructions, and the installation was made by Mr. Stephen D. Field, Sec'y. of the Electrical Construction and Maintenance Co. of San Francisco.

Fig 8 is a photograph from a sketch made by Mr. Field in a letter dated San Francisco, March 21st, 1877, addressed to Mr. Robinson:

In this letter Mr. Field says: "I am just in the receipt of yours of the 12th. I had anticipated your diagram and have the signals arranged as you show.

"I use the system connected up as follows:

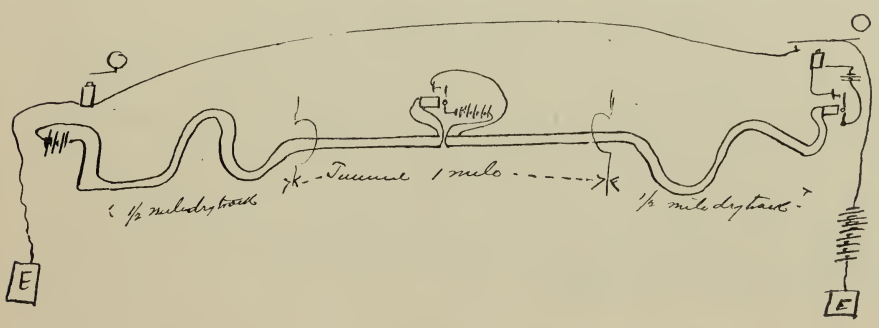


Fig. 8.

"In the tunnel the rails are buried in wet mud; outside no moisture touches them for six months of the year."

It will be noted that in the above case the signal section is two miles long, the tunnel being one mile long, with its rails

"buried in wet mud," and the section extending one-half mile at either end of the tunnel. An extra relay and battery are placed in the center of the section connected up as shown. Thus, where conditions require, a signal section may be divided up into a number of sub-sections.

Later advices showed that the above signals worked perfectly and gave entire satisfaction.

Insulated Joints.

In 1872 and early seventies Mr. Robinson insulated the rail joints to form the sections by wooden bars, substantially as shown in Fig. 9.

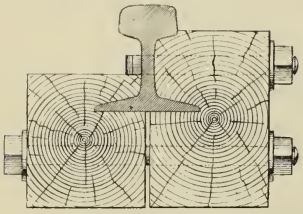


Fig. 9.

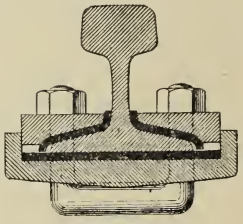


Fig. 10.

In 1876 and later he usually insulated the joints as shown in Figure 10, using the Fisher & Norris Trussed Joint as a basis. Vulcanized fiber is placed between the bottom of the rail ends and the base plate, and fiber is placed between the flanges of the rails and the forelocks, and fiber, the shape of the rail section is placed between the ends of the adjacent rails, all as shown in Fig. 10. This makes an excellent insulated joint, both mechanically and electrically.

Rail Bonding.

Dry rust forming between the fish plates and the rails of the track, at the joints, makes a poor conductor, and hence the low

current, from only one or two cells of battery used in the rail circuit for signaling is very liable to find sufficient resistance at the joints from this cause to prevent the continuous passage of the current through the rails to the relay.

Mr. Robinson discovered this difficulty in his first experiments in rail signaling in 1872 and the necessity for making a reliable electrical connection from rail to rail in order to insure the reliability of his closed circuit signal system.

As heretofore stated, therefore, he at that time conceived the invention of the bond wire, Fig. 11, for this purpose, the connection to be made by drilling holes in the adjacent rails, driving the ends of the wires tightly into these holes, and making the connection so close that there would be no room for moisture to penetrate or rust to form. And as an alternative form he proposed to secure the ends of the wire, or of a plate, to the adjacent rails by soldering, as shown in Fig. 12.

In those early days there were serious technical objections to both of these methods.

First: The difficulty and expense of boring holes in all the rails of the section and connecting them up, and the difficulty of getting the railroad company to consent to such an innovation to test what at that time might be regarded as an experiment, and

Second: Soldering seemed impracticable on account of the difficulty of heating up the rail quickly enough at the required point.

Mr. Robinson therefore, postponed the application of the bond wire until he could secure better facilities for applying and using it.

He, meantime, experimented along other lines however for the purpose of securing good electrical connection between adjacent rails without boring holes therein. One of these methods was very successful. It consisted in the use of elastic split springs having their ends resting on the flanges of the adjacent rails, and held in place by small blocks secured to the ties. The

passing of a train depressing the rails slightly caused a slight frictional movement between the rails and the springs, thus preserving good electrical contact.

In the West Somerville installation, near Boston, made in January, 1876, as heretofore described, Mr. Robinson, used the bond wire shown in Fig. 11. In applying this holes were bored in the rails, and the wire, fitting the holes as closely as possible, were forced in. A semi-circular punch was then carefully used to set the metal up close around the wire.

There has been no better bond wire devised since then except in mechanical construction. Bonds of various designs have been made heavier, and with heavier end plugs for mechanical connection to the rails.

These are good features as they render the bond less liable to breakage, and, as is well known, for electric railroading they should be much heavier than required in signaling, for the sake of conductivity.

A bond wire, to get best results, should be homogeneous, made of a single piece of metal, or if made of several pieces, all the pieces should be welded, or at least, soldered together. They should be of sufficient length to insure flexibility without disturbing the connection if the rails should move relatively to each other, and the whole circumferential surface of the plug end, or its equivalent, when possible, should be in the closest possible direct contact with the rail, that is, the bond plug should make connection with the rail as nearly as possible—homogeneous. Welding would be the ideal connection but it is not always practicable.

The reason for the above is obvious: that there should be no room left between the bond and rail for rust to form. It follows then that a bond held in position by an independent plug which renders it necessary for the current to pass from the bond to the intermediate plug and from that plug to the rail, is not the best form of bond, for the reason that it presents a double surface on which rust may form.

Figs. 11 and 12 show Robinson's bond wires and strips of 1872, figure 12 showing the bond soldered to the rail.

In 1876, 7 and 8 he used on various roads in the vicinity of Boston, the bond shown in figure 11. In 1876 he used on the Boston and Providence road the bond shown in figures 11, 13 and 14.

Fig. 11.

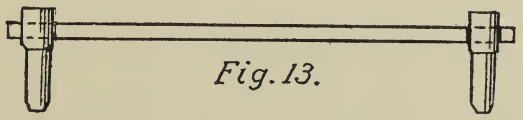


Fig. 13.

Fig. 12.

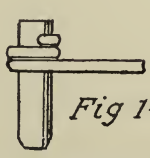


Fig 14.

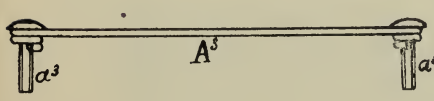


Fig. 15.

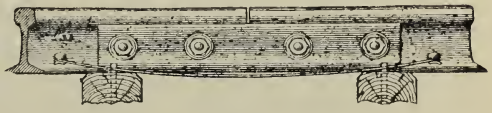


Fig. 16.

In the form shown in figure 13 holes are bored through the upper ends of the plugs, which were slightly tapering. The wire was forced through these holes, and the wire and plugs were then soldered together with hard solder. The plugs being materially larger than the wire could readily be driven home with a good deal of force, thus insuring an excellent electrical connection without endangering the wire.

In Robinson's British patent No. 3479, of August 29, 1879, aforesaid, he illustrated the form of bond shown in figures 15 and 16, which is an equivalent of that shown in figure 14, used by him in 1876.

Mr. Robinson claimed the bond wire broadly in this British patent, in the following claims:

10. "The wire A^3 in combination with the rails B^3, B^3, and securely fastened thereto, for the purpose described.

11. "In combination the wire A^3, the rails B^3, B^3, and the rivets a^3, a^3, the whole arranged substantially as described for the purpose of securing electrical continuity between said rails."

The above is believed to be the first disclosure of means for electrically connecting rails by a bond wire in any patent, although Robinson had disclosed it to various parties, and used it on installations years before.

On the subject of rail bonding the following bit of evidence may be of interest:

In a letter dated Baltimore, October 29, 1874, addressed to Mr. Robinson by Mr. J. H. C. Watts, of Watts & Co., manufacturers of Robinson's signal apparatus, he says:

"Am afraid your idea of soldering a strip of copper to the rails will prove very troublesome in carrying out, as it is a most difficult matter to heat so large a body of iron sufficiently to make a *sure* joint such as you require, or that will stand the jarring of passing trains &c., to say nothing of sneak thieves who abound wherever copper is lying around loose. I know however you scoff at *theory* so will 'dry up.' "

The electric dynamo of today has removed the above pointed out difficulty. Bond wires or strips are now welded to the adjacent rails for the purpose of securing reliable electrical connection between them. Welding is soldering, according to the definition of the term. Thus, the Encyclopedic Dictionary gives the definition: Solder: "To unite or cement together in any way. * * * "In autogenous soldering the two pieces are directly united by the partial fusion of their contiguous surfaces."

Thus, more than thirty years ago Robinson proposed to solder bond wires or strips to the rails for the purpose of securing good electrical continuity between the same. But it became necessary to wait some twenty years for the development of a commercially practical process for accomplishing this result. This is found in the modern electric welding process.

Robinson's object was to secure a perfectly homogeneous joint or connection between the bond and the rail. His invention, in this connection, consisted in a metallic bond arranged for electrically connecting adjacent rails of the track and means for forming a homogeneous connection between the bond and

the rails. This embraces any mode of accomplishing that result. Robinson had simply anticipated the electric process by some twenty years, but that process now accomplishes the result in a simple manner impossible thirty years ago.

The splice bars now welded to opposite sides of street rails in many places are used primarily for the purpose of electrically bonding the rails; incidentally they serve the double purpose of also making a good joint mechanically. Every electric railroad uses the bond wire or plate in some form, originally invented and used by Robinson, for electrically bonding rails together.

Thus, it is clear, this simple invention of Robinson made more than thirty years ago, an outgrowth of his original creation of the closed rail circuit system, has made possible the electric railroading of today, and the method of rail-bonding is now used on every electric railway using a rail return, throughout the world.

Fig. 17.

ROBINSON'S LATEST ELECTRIC SIGNALING APPARATUS.

RINGS A BELL ON THE ENGINE WHEN THE TRACK AHEAD IS ALL CLEAR.

Figure 17, above, is a photographic reproduction from a postal card dated "Sept., 1875," and issued at that time. It illustrates means for operating a positive safety signal in the cab of a locomotive when the track ahead is clear and safe, the operative current passing through the rails from the distant end of the track section upon which the train is entering.

This system is elaborated in Robinson's British patent of August 29, 1879, where it is shown operatively applied to a single track in such a manner as to operate a signal on a locomotive approaching from either direction, the operative current coming from the opposite end of the section—no line wires being used.

It is not thought necessary therefore to more fully describe the system here.

In General.

The scriptural injunction, "Prove all things, hold fast that which is good," is the key note of scientific progress. He who would discover truth must not accept anything *because* it is popularly accepted, or reject anything *because* it is popularly rejected; nor must he regard anything as impossible *because* never heretofore accomplished, although perhaps attempted by the most able scientists. While giving full weight to principles and laws demonstrated and verified by original investigations, he must bear in mind that those principles and laws may be capable of various combinations and interpretations; that the popular interpretation may not be capable of general application, and if not, it must be erroneous. In short he must enter upon his investigations systematically, independently and untrammeled by prejudice.

These remarks apply to Electrical Science with great force at the present time. Those who enter this field to advantage should be men of culture, of theoretical knowledge, and eminently practical.

These facts are illustrated by the efforts heretofore put forth in Europe and the United States to develop systems of rail signaling. Such efforts, in the early days, appear to have been exerted principally by theorists whose propositions and complications prove them to be not only ignorant of some of the fundamental principles of electrical science, but also, some of them, extremely unpractical. That the efforts in this direction may be fairly understood we will direct attention to a few of the systems of rail signalling proposed,—those which have elicited most attention—giving outline illustrations of some of the circuits which form their bases, and pointing out their defects and merits.

Early Rail Systems.

So far as we have knowledge, the idea of using the rails as conductors for electric signaling purposes was first suggested in an English patent of 1848. This was merely a suggestion,

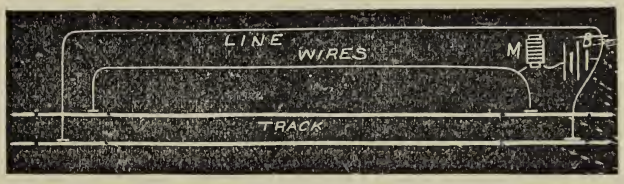
however, and no attempt was made to describe any specific method of using the rails for the purpose.

In 1853, however, an English patent was granted to George Dugmore and George Millward, in which is described a method proposed for using the rails as conductors. The design of the invention is to communicate between trains on the same line, and between trains and stations, for which purpose it is proposed to use long sections of rails. The unpractical part of this system is that to make it operate it is necessary, as the inventors say, to insulate the opposite wheels of all the carriages from each other, in order that electrical connection may *not* be established between the opposite rail lines by the wheels and axle.

Imagine one of our gigantic locomotives having its opposite drivers electrically insulated from one another!

In the following diagram M represents magnet and B battery.

Fig. 18.



William Bull's British Patent, October 31st, 1860, and Frank L. Pope's Experiment at Charlestown, Mass., in 1871.

Figure 18 represents the signal system described in William Bull's English patent of October 31, 1860. In this system, it will be observed, the rail sections used are short, "twenty feet, more or less," and are the terminals of line wires which connect with the battery and magnet at the station. The signal at the station is visual and consists in an indicator operated by wheel work actuated or controlled by the electro-magnet M shown in the diagram. The signal as described, moved in one direction only, by a step-by-step movement.

Mr. Bull says: "At the stations at which it is required that the progress of the train shall be indicated, a battery is fixed and in connection therewith a dial or indicator, both of which

are also connected with the line permanent way wire, the terminals of which are the pairs of insulated rails, as before described.

* * * * * * * *

"When the train arrives at the contact points on the line, the electric circuit would be completed by the wheels of the engine connecting the two insulated rails, when the current would flow and actuate the electro-magnetic armature," &c.

The mode of insulating the rails from each other is described by Bull as follows:— "Between the end of the rails, and also between the joint plates and rail ends, I insert a thin piece of leather, mill-board, gutta percha, or other suitable substance, suitable for cutting off metallic contact, and thereby insulate one rail of twenty feet, more or less, as may be necessary."

In Pope, in a description of his experiment at Charlestown, in a paper read by him before the New York Society of Practical Engineers—of which, by the way, Mr. Robinson was a charter member—and subsequently published, admits that he did not use the "rail circuit" at all in any proper sense of the term. On the contrary, he used line wires forming his main circuit terminating in short sections of rails, forty-two feet in length according to my recollection, that is, the length of one rail.

The train passing over the short rail section at one point closed the circuit through the line wires, thus exposing the signal, which was held in place by a "detent." The train, having reached a distant point, passed over another similar short section of rails, closing circuit through another magnet which released the "detent" and reversed the signal.

It will be observed that the essential features of the device used in Pope's experiment, on which he laid great stress, and described in Bull's patent, are identical, that is, the circuit closer consists, in the one case of a section of rails "twenty feet long, more or less," on open circuit, and the other identically the same, but with a rail section *42* feet long, both using line wires.

Pope and his friends heralded this experiment—a revival of Bull's device—as demonstrating a wonderful invention on the part of Pope.

It will be noted, however, that if the Pope and Bull devices were admitted to be practically operative, they are still simply normally open circuit systems, and open to all the objections of open circuit systems, as heretofore pointed out.

Fig. 19.

F. L. Pope, United States, July 16th, 1872; and Fred Barnes and David Hancock, British, February 10th, 1868. No. 447.

We now come to the more full consideration of rail systems, properly so called— that is, systems in which the main circuit consists of long sections of rails.

Figure 19 represents a system, patented in the United States, by F. L. Pope, July 16th, 1872. This system is a forcible illustration of the fact that invention repeats itself from year to year; thus while the above is an exact representation of the circuit, involving a long section of rails, shown in Pope's patent, the following description of the same is a *verbatim* extract from the records of the British Patent Office, where it was filed by Frederick Barnes and David Hancock, dated February 10th, 1868, more than four years prior to the date of Pope's re-invention of the same thing.

Barnes & Hancock's description of Pope's(?) system, figure 19.

"The first part of our invention consists in connecting the two poles of a battery with the two rails, the junction of the two being only completed at the time the wheels of a carriage, united by their axles, pass over the two rails; so that at all times except when a carriage or carriages is or are on the line of rails, the circuit will not be complete, but so long as a carriage remains on them the battery will work. Between one wire uniting the rail and the battery, we place a magnet, which acts against, or

which is capable of acting on, a lever, (of course when the circuit is complete,) and this lever is connected with a rod leading to the semaphore arms, or other signal on a post.

"As soon as the wheels of an engine, truck, or carriage place the battery in action by completing the circuit, the magnet attracts the lever, which throws the signal to danger. So long as the carriage remains on the line the circuit will be maintained; but as soon as the circuit is broken the battery will cease to act, and a weighted lever throws the signal to clear or caution, as desired.

"At a post, or a short distance in advance thereof, if preferred, we disconnect one rail from the other; we divide, as it were, the two rails, leaving a space between them no matter how small that space may be. As an engine for example, approaches the junction, the signal is at clear (the battery not being in action); but the instant the wheels cross the space dividing the rails, the circuit is completed, the magnet acts, and the signal is thrown to danger. So long as the engine or train remains on these rails so long will the signal continue at danger, but as soon as the last wheels of the last carriage have passed over the next division in the rails, the circuit is broken, and the weighted lever is free to throw the signal to clear. Of course the distance between the divisions in the rails may be regulated according to the distance it is desired to place the signals apart, the signals acting equally well whether the distance be a quarter of a mile or ten miles."

To whomsoever the credit of the above system may belong, it is a scientific absurdity of the most glaring nature, and never did, and cannot be made to, work over rail sections of any consirable length. Prior, it is believed, to its re-invention by Mr. Pope Mr. Robinson considered the system in principle and detail, and at once dropped it as too wildly absurd for serious consideration. The objection to it is, that the circuit being left open between long sections of rails, the ties and earth complete the circuit perfectly in wet weather, whereby the magnet is continuously magnetized, without the presence of the train. This is not merely theory, it is demonstrated fact. Although fully convinced of the absurdity of the method, Mr. Robinson deter-

mined to demonstrate its absurdity; he, therefore, performed a series of a dozen experiments on rail sections, ranging in length from one thousand feet to two miles, in weather snowy, rainy, damp and dry, on sections partly in contact with the earth, and on others wholly free from contact with anything but the ties, and with batteries arranged to secure the best results. In every case, without exception, the rails formed a perfect ground, keeping the circuit closed and the magnet magnetized.—demonstrating the fact that the presence of a train on the section would not affect the magnet or signal in the slightest degree, one way or the other.

The system in principle and detail is absolutely worthless.

Publications in the Iron Age.

On January 8, 1874, the Iron Age published an illustrated description of the Robinson Closed Rail Circuit System of Electric Signals.

This article seems to have grieved Mr. Frank L. Pope very much, and he sent a letter to that paper, which was published in the Iron Age on January 29, 1874, commenting on said article.

The gist of his comments was that in view of his revival of the Bull device of 1860 in his experiment at Charlestown, Mass., in which he used circuit closers composed of rail sections 42 feet long on open circuit; and of his patent of July 16, 1872, embodying long sections of rails on open circuit, fully described *verbatim* in the foregoing pages from Barnes and Hancock, British of 1868—both of which devices Pope no doubt imagined he had invented, and in view of these alleged inventions of his he thought that these open rail circuit devices entitled him to make a claim on the Robinson closed circuit system. The following is a quotation from his letter:

"Mr. Robinson also applied for a patent on the rail circuit, differing from mine only in the arrangement of connections, so that the magnet would be unmade instead of made by the passage of the train.

The above is a clear concession by Mr. Pope that he had never thought of the closed rail circuit.

It may be here remarked that in Electrics everything depends on the connections. Tie your wire to a tree and hitch a horse

to it and the wire is inert and the horse rests quietly; but connect the wire to a dynamo, and the horse becomes instantly as dead as Pope's circuits. "Only a difference in the arrangement of connections," forsooth!

Mr. Robinson's reply to Mr. Pope was published in the Iron Age of February 29, 1874. The following quotations therefrom are deemed sufficient.

"In your issue of January 29th a letter appears over the signature of Frank L. Pope on electric railway signaling, which, by stating too little falsifies truth, belies science, and is generally calculated to deceive your readers, scientific and general."

* * * * * * * *

"He [Pope] has already disclaimed my system over his own signature, and under oath, as I will show. On June 11, 1873, Mr. Pope applied for a patent which was granted October 7, 1873, on a device which was merely a modification of that shown in his original patent. In this application [filed, it will be noted, a year after the issue of my closed rail circuit patent] he also showed my system, giving the connections in dotted outline merely, and attempting to disguise the whole by complications, and calling it a 'modification' of what he showed as his invention. This he was compelled to disclaim, however, which he did in the body of the specification as follows: "I do not claim, by itself, the method of operating a signal by means of a constant circuit, which is shunted out of the operating magnet by means of a connection formed by the wheels and axles of a locomotive or car as shown in Fig 2, *except when combined with the devices and arrangements herein shown and described.*' The devices and arrangements are the complications referred to; these are of no value to Mr. Pope, as I will not permit him to use the 'constant circuit' with 'shunting' connections."

While Pope and his associates kept their hands off the Robinson system they were allowed free rein. But when their efforts to use the old Bull, and the old Barnes-Hancock systems, which proved in their hands a total failure, as a matter of course, and then thought it would be safe to take a hitch on the Robinson system without the flimsiest shadow of right, it was deemed time to call a halt.

Accordingly Robinson served an infringement notice on Pope and his associates under date of July 28th, 1874, calling their attention to the fact that they were infringing specifically seven claims of Robinson's patents, and, it was thought, six more claims, and demanding an immediate discontinuance of the infringements under penalty of an immediate suit for infringement.

This notice to Pope and Company was immediately printed in circular form and sent out broadcast to the railroads of this country.

After that we never heard of Pope & Co. doing another thing in the railway signal line.

In 1873 a general superintendent on whose road Pope placed several signals for testing, on being asked by the writer "How did Pope's automatic signal's work on your road?" replied: "They did not work at all." A Division Superintendent of the same road, who was present, said: "Pope's signal is not worth fighting for; it is not worth a baubee."

The superintendent of another road said: "Their signal is not giving us satisfaction."

We never succeeded in finding a single instance where Pope put up a signal that worked satisfactorily.

Mr. Pope has a well deserved fame as an electrician, as an ingenious inventor and as a fine and interesting writer—all along telegraphic channels. When, however, he turned his "prentice hand" to automatic railway signaling, it must be confessed that he made a total failure. He developed nothing new or original, but used only the inventions of others in his efforts to develop a signal system. He did not even show correct theoretical or practical knowledge of the principles involved in rail circuit signaling, which he was attempting to use. Nature and science were against him, and now, looking back over the field for thirty years it must be admitted that Mr. Pope never added or contributed anything whatever to advance the art of automatic railroad signaling.

I regret to feel obliged to write in this way of Mr. Pope, for whom personally I had a high esteem, but I am writing for the verity of history, and not sentiment.

Furthermore, I am giving more space to Mr. Pope than his work along the lines of signaling would seem to demand, for the reason that for thirty years his friends have been systematically publishing fraudulent claims as to the importance of his work in signaling even since his lamented and tragic death.

If any of these friends who have done so much to exhaust the ink vats of the printers feel aggrieved at anything written above, there is doubtless some ink still left in those useful receptacles. But the facts will stand, and may be proved by anyone disposed to investigate along the lines indicated.

The Robinson Automatic Electro Pneumatic Signal System.

As installed by the Union Switch and Signal Comany on all the tracks of the Pennsylvania Railroad between Jersey City and Philadelphia, and beyond, under the fraudulent pseudonym of the "Westinghouse Automatic Electro-Pneumatic System."

The above is a Robinson System pure and simple.

The records show that Westinghouse never invented an automatic electric signal system of any kind for control by moving trains, and the use of his name in the above connection is a high-handed piratical appropriation of Robinson's well earned credit and fame as the creator of an epoch making invention.

THE UNION ELECTRIC SIGNAL COMPANY.

Robinson's Organization.

In 1878 Mr. Robinson organized and owned the Union Electric Signal Company, based exclusively on his United States patents, at that time nine in number, which he assigned to the company on the completion of its organization. He received an equivalent for every share of stock in this company which passed out of his hands.

The Connection of George Westinghouse with Automatic Electric Signaling.

About 1880 George Westinghouse and his associates bought a controlling interest in the Union Electric Signal Company, thus gaining control of the Robinson Systems. They immediately reorganized the company under the name of the Union Switch and Signal Company, which latter company has been installing the Robinson automatic electric and electro-pneumatic signal systems ever since, and is now doing an immense business based on the Robinson systems.

Among the prominent installations of the Robinson Automatic Electro Pneumatic System is the complete equipment of the four tracks of the Pennsylvania Railroad between Jersey City and Philadelphia, and on to Paoli on the main line and Wilmington on the Washington line. The Pittsburg division of the Pennsylvania Railroad is also thus equipped. The system is also installed extensively elsewhere on the Pennsylvania Railroads.

The Robinson Automatic Electro-Pneumatic Signal System also embodies the complete signal equipment which controls and makes possible the frequent headway in the New York Subway, in which it is installed, and without this system the subway could

not run with safety half the trains it is now running, or carry half its present number of passengers. Without this signal equipment collisions in the subway would be the regular order of the day.

The Robinson automatic signal system is also installed on the Boston Elevated Railway, and controls the traffic of that road.

In short, the automatic signal systems now in general use on the leading railroads in the United States and in various foreign countries are the Robinson systems, pure and simple, all based on the closed rail circuit, an invention "created by Robinson," as the United States Court of Appeals, Third District, put it, and patented by him broadly in 1872. Over thirty years successful operation has proven this to be the only system that can meet the requirements of safe and efficient railroading, hence its extensive use.

The Union Switch and Signal Company, of which George Westinghouse is President, a reorganization, as stated above, of the original Union Electric Signal Company organized and owned by Robinson, made all the above named installations, describing and publishing them under the misleading and fraudulent pseudonym of "The Westinghouse Electro-Pneumatic System," with the deliberate purpose of conveying to the public and others the false and fraudulent information and impression that Westinghouse was the inventor of the system, well knowing that Robinson, and not Westinghouse, was the real inventor, and that in publishing Westinghouse as the inventor of the system, the Union Switch & Signal Company was, knowingly willfully, fraudulently and of malice aforethought committing a piratical and criminal depredation upon Robinson's credit and reputation, as an original discoverer and creator of an invention of untold value to the world in the saving of human life and property.

Now for the cold documentary evidence:

As heretofore stated, on August 20, 1872, Robinson received a broad, basic, pioneer United States patent covering the closed rail circuit system of signaling. This of itself would preclude the right of Westinghouse or any one else from attaching his name to the system in a manner indicating that he was the in-

ventor of the same even if he had made some improvement in signal mechanism mechanical or otherwise.

But this is not all; Robinson is specifically the original inventor and patentee of the automatic electro-pneumatic signal system as now extensively installed on many leading railroads, by the Union Switch and Signal Company.

In proof of this: British Patent No. 2280 was granted to Robinson under date of August 30, 1871, on "Electric Gate and Signal Apparatus for Railroads."

This patent covered several different systems of railroad signaling, among them the Electro Pneumatic System substantially as now extensively installed by the Union Switch and Signal Company. The system therein described shows all the essential features of the system as now installed by that company.

The following are some of the claims from this British patent, which proclaim the above facts with no uncertain sound:

31. "Operating a gate or signal by means of mechanism actuated by compressed air and controlled as regards the action of the mechanism or of the compressed air by means of electricity, as specified."

32. "A gate or signal operating apparatus consisting of mechanism actuated by means of compressed air and governed in its action by electricity when the currents of the latter are under the control of a moving vehicle or train, as specified."

33. "The magnet A2 so related to the piston rod C2 as to control or limit the movements of the same, substantially as specified."

34. "The magnet A2 with its armature lever B2 so related to the valve p5 as to control the same through the agency of suitable intervening mechanism, as specified."

44. "The air tank S in combination with the cylinder T of a gate or signal operating apparatus, as specified."

48. "A bell, alarm or signal operating by means of clock work N2, which is controlled in its action by an electro-magnet or magnets, and combined with an electric circuit or circuits actuated by a moving train or vehicle, as specified."

Other claims on the subject from that patent might be quoted, but these will suffice.

Robinson also received a French Patent dated Feb'y 29, 1872, No. 94 393. This French patent disclosed the same subject matter as the British patent above described, with some additions.

The French patent embodied, among other things, the closed rail circuit. Its claims, corresponding in number to those quoted from the British patent are an exact translation of the same.

The following is a translation of other claims of the French patent, relating specifically to the closed rail circuit:

Claim 88. "Connecting a battery B5 and a magnet M5 with the rails *a*9, *b*9 of a section of railroad track C5 in such a manner that when said rails are joined by a metallic bridge the electric current will be diverted from the magnet M5, but so that when said bridging device is removed from said section C5 the electric current will be free to pass through and change the magnet M5."

93. "A signal or signals audible or visual, in combination with the battery B5 and the rails of a railroad track, the whole being arranged to actuate the signal or signals, substantially as described."

The following claims also have a direct bearing on electro-pneumatic signaling, from Robinson's United States patent, No. 267,259, dated Nov. 7, 1882 Electro-Pneumatic Gate and Signal Apparatus; assigned to the Union Switch and Signal Co.:

Claim "*1.* The combination, substantially as hereinbefore set forth, of a motor automatically controlled by a moving vehicle and driven by fluid pressure for actuating or changing the position of a gate or signal, and a weight operating under the force of gravity to reverse at times the action of said motor, and thereby restore said gate or signal to its original position.

"*2.* In a gate or signal operating mechanism, the combination, substantially as hereinbefore set forth, of a piston moved to and fro within a cylinder by fluid-pressure and by the action of a weight, a valve to govern the movements of said piston by controlling the admission and exit of the fluid to and from said cylinder, and means for automatically operating said valve through the movements of a moving vehicle.

"*3.* The combination, substantially as hereinbefore set forth,

of a gate or signal actuating mechanism, a valve by the opening and closing of which the operations of said mechanism may be governed, an electro-magnet and armature, and an escapement device whereby the alternate opening and closing of said valve is made to depend upon the movements of said armature."

In connection with the above described patents of Robinson of 1871 and 1872, both United States and Foreign, it is to be noted that George Westinghouse had no connection with automatic railroad signaling until about 1880, at least nine years after the patenting of the described electric and electro pneumatic systems by Robinson, and that when Westinghouse did become interested in automatic signaling it was only by the actual purchase of stock in the Union Electric Signal Company, organized and owned by Robinson, as described, and not by means of any invention made by Westinghouse.

It is scarcely necessary to say that such purchase did not give Westinghouse the right to appropriate to himself Robinson's credit and reputation, or the right to fraudulently and piratically advertise himself as the inventor of the system, to the great damage of Robinson and corresponding profit and advantage of Westinghouse.

George Westinghouse's Reputation as an Inventor.

Mr. George Westinghouse is an able business man, a successful promotor and an ingenious inventor, especially in the matter of making improvements in details based on other men's inventions, and withal, a notoriously unscrupulous appropriator to himself of the credit and reputation of making inventions actually made and even patented, by other men, and fraudulently promulgating the same as his own inventions.

The pedestal on which his reputation as an inventor stands is composed of the work of perhaps five hundred actual inventors, every block in the pedestal emblazoned with the pseudonym "Westinghouse," the combined work of the suppressed and imprisoned geniuses within radiating a glorious effulgence upon the complacent monument above.

In justification however it may be explained that it is the cus-

tom in some of the large manufacturing concerns to require all employes to assign to the company all inventions and improvements they may make in their particular line of work.

The Westinghouse companies have large numbers of the ablest and most ingenious men in their various lines of work. These men naturally make many inventions and improvements. These are patented, at the expense of the company no doubt, and the men receive their ordinary wages. The reputation and credit due them are thrown into the Westinghouse hopper; the crank is turned and the grist comes out stamped in every instance with the pseudonym "Westinghouse."

But this is not the most reprehensible way in which Westinghouse acquires a spurious reputation as an inventor. He becomes interested in an invention by purchase. Immediately the inventor's name is obliterated and the invention is published as a "Westinghouse" invention, without the inventor's permission. This is rank piracy, the work of an unscrupulous buccaneer, a fraud upon the inventor, a stealing and appropriation of his reputation, his own private property, and an imposition and deception practiced upon the public.

In this connection it is extremely difficult to find language sufficiently forcible in which to properly characterize and denounce George Westinghouse's most unjust, unwarrantable, unscrupulous and criminal piracy in his appropriation of Robinson's credit and reputation as the creator of an epoch making invention, of which Westinghouse is guilty in publishing the Robinson Automatic Electro Pneumatic Signal System under the fraudulent and spurious title of the Westinghouse electro-pneumatic system.

In order that I might not by any possibility do Mr. Westinghouse an injustice I had a careful search made of the Patent Office records covering a period from 1880, the time when Westinghouse first became connected with automatic signaling, down to the present time, to ascertain if Westinghouse had received any patents on improvements in automatic signaling. Several patents were found taken out by him or interlocking. switch operating from cabins, and such matters, which have nothing to do with automatic signaling.

Two patents however were found taken out by Westinghouse on automatic electric signaling, the first dated January 16, 1883, No. 270,867.

This patent describes the Robinson system, pure and simple, including his overlapping system, as installed by him in 1872 and subsequent years. Its subject matter is described herein in extracts from Robinson's circular of 1872, and is also described, and illustrated in Fig. 3, from his circular of 1874.

This patent was a monstrosity. It was born eleven years too late, and bore the birthmark of illegitimacy. It was found to be void for want of novelty by the United States Courts. More of this later.

The other patent referred to is dated April 5, 1887, No. 360,-638. The invention embodied in this patent is stated to be an improvement on that covered by the above named voided patent; that is, it is an "improvement" on a thing that does not exist. It is a Westinghouse patch on nothing,—the material of which the Westinghouse "system" is made.

This patent shows and describes by name the Robinson closed circuit and is the Robinson system, with a slight modification in the detail of a local circuit closer. It could not give the patentee any right to use the system, to say nothing about his right to attach his name to it.

This patent illustrates, but does not describe, the Robinson electro-pneumatic system.

Note also that this patent is dated sixteen years later than Robinson's British Electro Pneumatic Signal patent of 1871.

So far as we have been able to ascertain, George Westinghouse never invented an automatic electric or electro-pneumatic railway signal system of any kind whatever controlled by passing trains, and never made any material improvement, even in the details, of any such system. He appears, therefore to have added absolutely nothing to the art of automatic signaling in the line of advancing it beyond the condition to which Robinson had developed it more than thirty years ago.

Westinghouse struts under stolen plumage, and when this is torn off he appears as a vulgar bird of prey ravenously seiz-

ing, devouring, digesting, assimilating and growing fat, arrogant and wealthy upon other men's reputation and work.

If any one will inform the author of any important invention origiated, developed and reduced to practical operation by George Westinghouse personally, referring to documentary evidence that would pass muster in a court of law, that Westinghouse was the originator of such invention, the author will feel under great obligations. This invitation is not limtied as to persons.

In a forest of parasitical and fungus growth it would be very gratifying to find even one noble tree towering high above the surrounding noxious weeds and raising its lofty head toward heaven without feeling that it must veil its face to hide a blush of shame because of its own doubtful lineage and suspicious surroundings.

The Robinson Automatic Electric Signal System.

As installed by the Hall Signal Company on the N. Y. Central and Hudson River Railroad, under the fraudulent pseudonym of the "Hall Signal System."

The above system was broadly patented by Robinson in 1872.

The Hall Signal Company adopted the Robinson system on the expiration of his basic patents, but unjustly, dishonestly and piratically put the Robinson system forward under the fraudulent pseudonym of the "Hall Signal System" although the real Hall System, so called, had died of inanition years before. This bold theft and underhanded attack on Robinson's reputation as an epoch making inventor is actionable in law and renders its perpetrators liable to heavy damages.

The Hall Signal Company.

About 1867 Mr. Thomas S. Hall put in operation experimentally at Stamford, Conn. an electrically operated visual switch signal. This was connected up in such a way that the throwing of the switch from the main line to a siding closed an electric circuit and brought a danger signal into view. The return of the switch to the main line opened the circuit and the signal disappeared. This was all. It was a normally open circuit device, and of course possessed the inherent objections to such devices as already pointed out.

It was not until several years later, according to authentic records and information, that Mr. Hall commenced experimenting on automatic signals controlled by passing trains.

After much experimenting and many failures he finally developed what has heretofore been commonly known as the Hall System of Signaling. It was a normally open circuit system. The signals were brought into the danger position by the direct action of the electric current and passed to the "safety" position by the weight of the signal itself or by a counterweight, when the electric circuit was opened. The circuit was closed by the impact of the wheels of the cars upon a lever placed at right angles to a rail of the track block, and opened by wheel contact with a similar lever at the other end of the block.

This system was open to all the objections inherent in all open circuit systems, as heretofore pointed out, and they need not, therefore be here repeated.

About 1870-71 Robinson and Hall were both experimenting on automatic open circuit systems, along the same general lines;

that is, each used the open circuit and track levers to close and open circuit. The systems differed in details of construction.

Robinson always believed that the Hall system, as above described, was an infringement of some of his earlier patents of 1870,—applications filed earlier.

After Hall had put several signals in operation on the N. Y. N. H. & H. R. R. Robinson called on President Bishop of that road and informally notified him that the Hall signals were an infringement of his patents.

Mr. Bishop said he was not familiar with the signals, to which Mr. Robinson replied: "That may be; but you have been Commisisoner of Patents and are undoubtedly familiar with the scope of patent claims; will you have the kindness to look over these?

Mr. Bishop looked carefully over the Robinson patents presented to him and then said: "Well, if you are going to contest this matter we will take the signals off."

Further investigation showed, however, that the Hall signals were not working properly or satisfactorily on this or any other road, and Robinson concluded it was not worth while to make a contest over a spavined horse.

He therefore allowed Hall to go on his way without interference. The more so, as he, Robinson, had abandoned the open circuit system as soon as he had invented, and demonstrated the utility of his closed rail circuit system, now in universal use.

Mr. Thomas S. Hall was very persevering, but unfortunately, could never see a weak point in his own work. If it was the work of Thomas S. Hall it must be correct, seemed to be his principle. Furthermore, he seemed anxious to put out signals as rapidly as possible without first having tested one or two installations sufficiently to develop the best results possible in an impossible system.

As a result, so far as I have been able to ascertain, the Hall Signal Company never met with any substantial success or succeeded in installing equipments that gave satisfaction to the users, and certainly never succeeded in making an installation that met the imperative requirements of an efficient block sig-

nal system, as that was impossible with an open circuit system, such as the Hall.

The Hall Signal Company succeeded in maintaining a precarious existence, through various vicisitudes for a number of years, and at the time of the expiration of the Robinson basic patents, about 1889, had arrived at the blissfull condition of *innocuous desuetude.*

Meantime Mr. W. P. Hall, the youngest son of Thomas S., and the present President of the Hall Signal Company had been making a careful study and investigation of the Robinson closed rail circuit system, and concluded that this was the only force available that could pull the Hall Signal Company out of the slough of despond into which it had sunk, and start it on a career of success and prosperity.

The Hall Signal Company Reorganizes.

The Hall Signal Company immediately reorganized and adopted the Robinson System instead of the defunct Hall system, which, like any other member of the public, it had a right to do, in view of the expiration of the Robinson basic patents, which had become public property.

The Hall Signal Company, however, put forward and installed the Robinson Signal system and published it to the world under the false, fraudulent and misleading pseudonym of "The Hall Signal System." This crime against Robinson's credit and reputation as the author and creator of a great and valuable original invention the Hall Signal Company committed deliberately, knowingly, falsely, fraudulently and of malice aforethought, and for this it is responsible. It deliberately stole the panoply of Robinson in which it wrapped its own attenuated form and thought to deceive by attaching the name "Hall" in large characters to the effigy. It stole the lion's skin, in which it wrapped itself, and would pass for a lion, but the long ears could not be concealed, and while the hoofs may have become cloven and the tail perhaps somewhat spearlike, yet the whole foul combination was there and when it opened its brazen

throat and exclaimed "Am not I a lion?" even the blind heard the well known voice and laughed in derision.

Perhaps the first prominent installation of the Robinson track circuit system made by the Hall Signal Company, under the fraudulent and piratical pseudonym of "The Hall Signal System" was made on the Illinois Central Railroad in connection with the World's Fair in Chicago in 1893. This Robinson Automatic System was used to control the movements of trains to and from the fair grounds, running on a headway of a fraction of a minute.

In an annual report of the Railroad and Warehouse Commissioners of Illinois, published in the Railway Review of August 18, 1894, in referring to the operation of these signals during the last half of 1893, they say:

"We are informed by the management of the Illinois Central that not a single accident occurred on that part of their line protected by the block signals during the World's fair traffic, which could in any way be attributed to defects in the block system; the average number of daily trains handled was between seven and eight hundred, and the number of passengers carried during the period of the fair was nine million six hundred thousand, exclusive of through passenger business."

This marvelous record of the efficiency of the Robinson signal system could not have been made, probably, with similar freedom from accidents, by three times the number of trains on three times the number of tracks without this signal system.

That the above described installation is confessedly an embodiment of the Robinson automatic system, pure and simple, installed on the Illinois Central Railroad by the Hall Signal Company, under the fraudulent pseudonym of the "Hall Signal System" is demonstrated by the following description of that installation from the Railway Review of January 28, 1893:

"The signal apparatus used is the Hall system." * * *

Then follows the following excellent description of the Robinson system, as used by the Hall Signal Company, without any modification whatever:

"At this point the track circuit is introduced. The operation of this circuit is generally understood. The track is divided into

insulated sections not exceeding 2000 feet in length. Adjacent rail ends are bonded together with two wires. At the end of the insulated section farthest away from the signal is located the track battery consisting of two cells of ordinary gravity battery, connected in multiple. One side of this battery is connected to one rail of the section, and the other side to the other. That end of the section nearest the signal is connected to a relay in the same manner—one rail to one side of the relay and the other to the other side.

"The normal flow of the current is from one side of the battery through one rail and the relay to the other rail and back to opposite side of battery. This current holds up the armature of the relay and in so doing closes a local circuit which passes through the signal and holds it clear. The entrance of a pair of wheels on the insulated section furnishes a path for the current through the wheels and axles having less resistance than that through the relay. The current takes this path and cuts out the relay. The armature drops, breaking the local circuit and the signal goes to danger."

Compare the above with the description of the Robinson system as described and illustrated heretofore in connection with figures 2 and 3, then sweep the horizon with the highest power telescope and search diligently, though in vain, for the uncreated infinitesimal atom in vacuity, of honor, honesty, and fair-mindedness of the party putting forward the Robinson System of Automatic Electric Signals bodily, as above described, under the spurious and grossly fraudulent appellation of the "Hall" Signal system.

The Hall Signal Company relies upon carbonic acid gas as the medium for mechanically actuating the signal, by fluid pressure, and the action of this gas in performing its work is controlled by the Robinson closed track circuit with which it is connected.

But even this method of operating a signal by electrically controlled gas pressure is broadly anticipated by Robinson's U. S. patent No. 267,259, dated Nov. 7, 1882, Electro-Pneumatic Gate and Signal Apparatus, by the following claims:

"1. The combination, substantially as hereinbefore set forth, of a motor automatically controlled by a moving vehicle and driv-

en by fluid-pressure for actuating or changing the position of a gate or signal, and a weight operating under the force of gravity to reverse at times the action of said motor, and thereby restore said gate or signal to its original position."

"2. In a gate or signal-operating mechanism the combination, substantially as hereinbefore set forth, of a piston moved to and fro within a cylinder by fluid-pressure and by the action of a weight, a valve to govern the movements of said piston by controlling the admission and exit of the fluid to and from said cylinder, and means for automatically operating said valve through the movements of a moving vehicle."

Again, the Hall Signal Company is putting forward as something new what it is pleased to call the "normal danger" signal system. That is, the Robinson closed rail circuit is used in the usual way; but the local circuit including the signal-controlling magnet under control of the relay is normally an open circuit and consequently the signal, overbalanced by its counterweight, is normally in an exposed or danger position against an approaching train. When the train, however, enters upon the section with which the signal is connected the relay is demagnetized by short circuiting in the usual way. The armature, thus released, closes circuit on the back contact of the relay thus closing the local circuit through the signal controlling magnet. The danger signal is thus thrown to the safety position in the face of the approaching engineer by the vitalizing of the local or signal-controlling magnet.

Mr. Robinson used this identical arrangement and operation of circuits in 1872, and later.

(See description of Robinson's exhibit at State Fair, Erie, Pa., 1872.)

In an application which he made in 1872, as above described, the demagnetization of the relay by short circuiting closed the local circuit at the back contact of the relay including the signal controlling magnet thus controlling the movement and actuation of the signal mechanism. When the relay magnet was energized the local circuit through the signal controlling magnet was opened and the signal was thus normally quiescent or "dead."

When a gong is placed in the local circuit it is silent when

the section is clear and the relay vitalized, but when a train enters upon the section thus de-energizing the relay the local circuit is closed and the bell rings. On the other hand when a visual signal is used and the relay vitalized the local circuit is opened and the signal is thus kept in a quiescent state by its counterbalance, and reversed by the closing of the local circuit when the relay is demagnetized.

This arrangement of circuits is also shown, substantially, in Fig. 3, herein, reproduced from Robinson's circular of 1874, in which the de-energizing of the relay R closes the local circuit through its back contact, the wire G, the line wire H and gong L. In this circuit however, an additional function is introduced, inasmuch as the circuit through the line H is not completely closed until the signal C is in its exposed or changed position. In this case the de-energizing of the relay opens the circuit of the home signal and, closing circuit on its back contact, actuates the distant signal and thus proves the danger position of the home signal.

The substitution of one form of signal for another, whether visual or audible, does not involve patentable invention, and the trifling modification of using the local circuit on normally open or normally closed circuit Mr. Robinson regarded as optional with him under his patents and not involving any patentable difference. At any rate he put both methods in actual operation, according to his convenience and purposes, in 1872 and subseqeunt years.

In view of the foregoing the pretensions of the Hall Signal Company to possessing anything original in the so-called Normal Danger Signal System'' seems to have no better support than a broken reed and a staff of pretension.

Federal Court's Decision on Robinson's Invention.

Some years ago the Union Switch and Signal Company brought suit against the Philadelphia & Reading Railroad Company and the Hall Signal Company for infringement of five patents, two granted to Oscar Gassett, one to Gassett & Fisher one to George Westinghouse, Jr. and the other was on a small de-

tail having no bearing on the art and was decided not infringed.

The case was tried before the Circuit Court of the United States for the Eastern District of Penna.

The Court decided that the Hall Signal Company was using the Robinson Signal System covered by Robinson's expired patents, which had become public property, and therefore there was no infringement.

The case was appealed to the United States Circuit Court of Appeals, Third Circuit, which affirmed the decision of the lower Court.

The following is from the Court's discussion of the Gassett patents:

"Long before October, 1880, which is the date of granting patent No. 233,746 (Gassett's) William Robinson obtained in the United States, patent No. 130,661, dated August 20, 1872, the object of which was to operate electric signals by means of moving trains, using the rails of the track as conductors of the electric current. He divided the track into sections insulated at the ends and created a circuit normally closed which held the danger signal at safety. When the train entered upon the section the electric current short circuited through the wheels and axles of the cars and thereby demagnetized the electro magnet which held the signal at safety and caused it to change to danger. The specification of this patent also set out the means by which any desired number of signals could be operated at different points from a single section of track. Robinson in his British patent dated August 29, 1879, also says: 'One or more lines of wire may also be used to operate additional signals, for instance to indicate when the block signal has changed.' "

"The expressed objects of both inventions [Gassett's] are to supplement an old device and one well known in the art. It will be seen that the division of the track into insulated signal sections having a normally closed circuit holding the signal at safety, together with the breaking of this circuit by the passing of the electric current through the wheels and axles of the moving train, and thereby placing the signal at danger, was but the Robinson device hereinbefore referred to, while the means employed for the continuation of the exhibition of the danger sig-

nal during the time occupied by the train in traversing a determinate portion of the next succeeding signal section alone had the semblance of novelty. This continuation of the danger signal has been preshadowed by Robinson."

The Westinghouse patent of record describes the Robinson system specifically and refers to it as "the well known Robinson closed track circuit system," * * * and says: "This, also, is common to the Robinson system referred to; but instead of using these magnets to actuate signals I employ them as relays."

Robinson put in operation in 1872, everything, substantially, embodied in the subject-matter of the above described Westinghouse patent, and embodied the same in every signal installation which he made subsequently thereto. Furthermore he described the same in a circular issued by him in 1872, and illustrated the same in a circular issued by him in Sept., 1874, a reproduction of said illustration is found in figure 3 of this paper. Thus Westinghouse, in taking out the above patent in 1883, was just eleven years behind Robinson's actual invention and reduction to practice of the same thing.

As to this Westinghouse patent the Court says:

"We are of opinion that the patent No. 270,867 is void for want of novelty."

As to the Hall installations the Court says: "An examination of the defendant's device shows that he has embodied the Robinson principle which was free to the world."

Again the Court says: "Both complainants and defendants operate upon the Robinson principle."

Thus, while Robinson had no personal interest in the above suit the Federal Courts have vindicated his reputation as the "creator" of the closed rail circuit of signaling as against both of the freebooting pirates, Westinghouse and Hall.

Concession by Counsel for the Hall Signal Company.

Counsel for the Hall Signal Company, in his argument before the Court of Appeals in the above suit made the following remarkable concession:

"Defendant's operation is, in every part and parcel, on every

foot of every section, and over every signal, a Robinson operation pure and simple, * * * * the track magnet always, and for every purpose, acting as a relay, as prescribed by Robinson, to open a secondary circuit containing the signal; in fact containing two signals, as also prescribed by Robinson, and each section in that way controlling, through an ordinary double relay, three signals, as Robinson says may be done—namely, one home and two distant signals (a near one on the same post with the home and a distant one a mile to the rear). Every characteristic Robinson feature is retained. Every signal taken by itself is a pure Robinson signal. The whole taken together is a mere assemblage of Robinson signals."

How does the above voluntary statement made by Counsel for the Hall Signal Company, before the Court of Appeals, comport with the fact that for years the Hall Signal Company has been deliberately installing the above described system under the pseudonym of the "Hall Signal System?"

The following further extract from the above named argument will doubtless be of interest to signal engineers: "But the 'real protection' here spoken of was given to the art by Robinson. * * * That is to say, the idea of, and the means for, holding a signal completely under the control of the train after that train had passed the entrance to the portion of track which that signal is designed to guard came from Robinson, and came wholly from Robinson. That is a question of the *method of train control over signals*, and has nothing to do with the presence or absence of an overlapping arrangement of the so-controlled signals. Robinson fully disclosed the closed track circuit method of train control over signals and *generically disclosed it*, and the entire credit for the continuous and complete control of the train over the signal thereby secured is due to Robinson, whether one use or application or another be made of that method, and whether it be exercised from one portion of the track or another, and whether it be extended to one length of track or to another, and whether those lengths of track so controlling adjacent signals overlap each other or not, and whether one or more signals are simultaneously so controlled from a given section of track."

Oscar Gassett's Connection With Automatic Signaling.

In December, 1875, as heretofore stated, Robinson went to Boston and took up his residence there. At that time Gassett & Fisher had a small shop in Boston for manufacturing electrical apparatus,—jobbing. Fisher was the mechanic, and a very good and reliable workman. Gassett was a clerk in the Boston post-office, and spent much of his off time at the shop tinkering over something. He never showed any signs of mechanical ability or originality.

Mr. Robinson engaged this firm to manufacture most of the signal apparatus which he used in installing his signal system on various roads in Massachusetts, as heretofore described, during the years 1876-7-8.

Gassett took a great interest in the Robinson signal system and became intensely anxious to become personally interested in it in some way. Robinson, however, considered him a rather light weight and did not at first regard him seriously.

Gassett, however, had the excellent quality of being very persevering. It transpired also that he had some wealthy and influential friends and relatives. Mr. Wendell Phillips was his uncle, and it was only at the personal suggestion of Mr. Phillips that Robinson consented to give Gassett a chance to connect himself with the Robinson automatic signal system—as a promoter only, his interest and connection with the system being entirely contingent on his success as a promoter.

In line with this determination Robinson authorized Gassett to equip ten miles of the Fitchburg Railroad with the Robinson automatic signal system. This was in 1878.

I may now here introduce a matter of some importance because of its bearing on coming disclosures:

Some time before going to Boston Robinson prepared a specification and drawings preparatory to applying for a patent on his rail bond wire. The specification was verified and ready for filing, and the drawing was completed and ready for inking. These papers he loaned to Gassett, in December, 1875, or January, 1876, and Gassett and Fisher both became familiar with the bond wire from these papers and Robinson's explanations of

the necessity for using them and the necessary points to be observed in applying them.

Some time afterwards Robinson asked for the return of these papers but Gassett professed not to be able to find them. Robinson often repeated his demand for the return of these papers during months and even years afterwards, but the papers were never returned.

Meanwhile preparations were going on for the equipment of the Fitchburg railroad, as above described. Gassett seemed to have a pretty poor opinion of the Robinson rail bond. He thought he could do better. He therefore got up a device, by courtesy called a rail bond, each bond consisting of five detachable pieces including two cast iron clamps for clamping the device to the flanges of the rails. It proved an utter failure both electrically and mechanically, and had to be taken off almost immediately and the Robinson bond wire substituted.

I have recently had in my hand a clipping from a Boston paper giving an account of a visit made by certain gentlemen to see the operation of the installation of the Robinson automatic signal system just after it was put in operation on the Fitchburg Railroad.

That slip stated that the system was the "invention of Gassett & Fisher and Robinson." Observe the sequence of the names! As a matter of fact, however, Gassett and Fisher had not at that time invented any part or improvement whatever in connection with the system, not even what might be covered by the shadow of a finger tip at midnight.

The above, however, is merely a straw. The fact seems to be that Gassett was developing an almost insane desire to be known in some way as an inventor in connection with the Robinson system, as will appear from what follows:

Mr. Robinson went abroad in March, 1879, and was gone fifteen months returning in June, 1880. While he was gone, on May 4, 1880, Gassett & Fisher took out a United States patent on the Robinson bond wire described and illustrated in the papers which Robinson loaned to Gassett nearly five years before and which were never returned.

The above patent seems to explain why those papes were never returned. On returning from abroad, I asked Mr. Fisher

to explain why he joined Gassett in taking out a patent on the Robinson bond wire. He explained that the attorney for the company told him that it would be all right, and so he thought it must be, Robinson being out of the country.

Mr. Fisher as I have intimated, was an ingenious and skilled mechanic, and, I believe, a thoroughly honest man but knew nothing about patents or patent law and I cheerfully acquitted him of any intentional wrong doing in the above matter.

In the suit between the Union Switch & Signal Company and the Hall Signal Company, above described, Gassett was a witness and on being questioned admitted that he had received from Robinson the papers on the bond wire as above described.

While Mr. Robinson was abroad a very full illustrated description of the Robinson automatic signal system, in its various phases and applications, was published in the Railroad Gazette, covering six and a half pages. The article was prepared by Mr. Thomas F. Krajewski.

In introducing the description of the system the article says: "Mr. Oscar Gassett is its principal inventor." Robinson's name is not mentioned at all, nor is that of any one but Gassett.

The above unclarified falsehood is doubtless explained by the fact that in Robinson's absence J. Gardiner Sanderson, Gassett's cousin, was Manager of the company and Oscar Gassett Superintendent. They thus had the best possible opportunity to impose upon Mr. Krajewski and lead him to unwittingly publish a base falsehood to the world, while Gassett could hide behind Robinson's absence, and congratulate himself on the fugitive fame he had acquired by an insane plunge into the fountain of Mendacity, a palpably short sighted plunge which seems to justify a suspicion as to his mental responsibility.

The system described in the paper is the Robinson system pure and simple.

A careful review of all the facts fails to show that Gassett ever added anything to the art of automatic signaling. He got the subject-matter for the spurious patents which he secured from disclosures made to him by Robinson, as illustrated by his conduct in respect to Robinson's bond wire, as above described, for instance.

Infringements.

In the New York Subway the alternating current from a step-down transformer, is used to magnetize the track relays for signaling purposes in order the more readily to prevent interference between the propulsion and the signal controlling currents. When the subway was opened in 1904, this application of the alternating current was heralded as a most wonderful improvement. It was said to open up a field in some respects revolutionary and is considered essential to the successful operation of the subway system.

This discovery however, like some others of the Union Switch and Signal Company, was rather belated in making its advent into the world.

Mr. Robinson took out a patent on an Electric Railway System, dated Sept. 1, 1896, No. 566,801, application filed Dec. 19, 1894, generically covering the same invention, as will appear from the following:

Claim II. "The combination, substantially as described, of a continuously closed circuit, a magnet included in said circuit and operated or controlled without actually opening the circuit of said magnet, a transformer arranged to energize said circuit with a current of low voltage derived from a current of higher voltage and means for demagnetizing said magnet by short circuiting."

Again, in the signal installations made by the Union Switch & Signal Company on the Boston Elevated Railway, and the Pennsylvania Railroad, and presumably on many other roads, the sectional conductors are furnished with current from a single generator connected in multiple to various sections.

This construction and arrangement are anticipated generically by claim I of Robinson's patent No. 580,057, dated April 6, 1897, application filed January 21, 1895. The following is

Claim I. "The combination, substantially as described, of a plurality of electro-magnets included in a continuously-closed circuit formed in part of two parallel lines of sectional contact conductors, said magnets being operated or controlled without

opening the circuit of the same, an electric generator furnishing current to said magnets through said parallel sections of contact conductors, and means for demagnetizing each of said magnets in succession, independently of the others, by making short circuiting contact between said respective parallel sections of contact conductors."

It will be seen from the foregoing that the Boston Elevated Railway Company, the Interborough Railway Company, operating the New York Subway, the Pennsylvania Railroad Company, and probably many others, are all infringing the above patents, which are the exclusive property of Mr. Robinson and that the Union Switch and Signal Company is a general infringer of the same.

Reputation as an Asset.

Mr. Robinson's life work has been devoted chiefly to improvements in connection with railroads.

It will be understood therefore that the credit and reputation of having, at the beginning of his career, created an epoch-making invention of incalculable value to the human race in the wholesale saving of life, limb and property on railroads, must be an asset of well nigh incalculable pecuniary value, to say nothing of its sentimental interest, in the course of twenty-five or thirty of the best years of his life. The value of such an asset must, in this case run up very high into the hundreds of thousands of dollars, and as dollars are counted in these days, doubtless into the millions.

This is a rough estimate of the tangible inherent property rights of which George Westinghouse, President of, and in conspiracy with, the Union Switch & Signal Company, and William P. Hall, President of and in combination with, the Hall Signal Company, have deliberately robbed Robinson, as criminally as if they had waylaid him in a dark wood and stolen this property by force of arms; and as to conscience or remorse! But why discuss a nonentity? Moral paresis obliterates conscience.

It has heretofore been pointed out that the Federal Courts have already decided that the Union Switch & Signal Company and the Hall Signal Company, are both using the system "created by Robinson." This is a Court of Appeals decision that Robinson, and nobody else, is entitled to the credit and reputation of having "created" this invention.

Under the circumstances an injunction can doubtless be obtained against these reputation-pirates on application, and exemplary damages by due process.

It may be here pointed out that the great business success of the Hall Signal Company is based exclusively on its use of Robinson's inventions, and the phenominal success of the Union Switch & Signal Company is based chiefly on the Robinson inventions, and the inverted-pyramid reputation of George Westinghouse as an inventor has been immensely expanded,—not to say rendered top heavy to its fall—by the grand larceny and adding thereto, by George Westinghouse, of Robinson's credit, work and reputation as a creative and epoch making inventor.

What Robinson Has Done in Automatic Electric Signaling.

1. He has created an epoch making invention of incalculable value to the human race in the wholesale saving of life and property on railroads, an invention of increasing importance and efficiency as time passes and its use is extended.

It is an invention so unique and profoundly philosophical that those best skilled in the electrical art at the time it was made, declared that it was contrary to all known laws of electrical action and could not possibly work. It took years after it was in full and perfect operation to educate some of these wiseacres up to it.

2. Robinson's invention was not an improvement on something that preceded it. It had no precedent. It was an entirely new creation involving principles and methods of operation never before known or used by anybody.

3. His invention was almost unique in this: It was a basic

invention conceived, tested, put in practical operation in many installations, and *perfected,* as a system, in all its details, by its original inventor. He reduced it to its lowest terms and its highest efficiency, a perfection and efficiency of operation which have not been exceeded since it left his hands many years ago.

4. His invention has made possible, with safety, the high speed railroading of to-day. Without this automatic signal system of lightning expresses now running could not average half their present speed with safety.

A PRACTICAL ILLUSTRATION:

5. As already stated, the automatic signal system used in and controlling the operation of traffic of the New York Subway is purely and exclusively a Robinson system.

The magnitude, importance and value to humanity of this Robinson invention may be understood at a glance, as follows:

Suppose that all the automatic electric signals in the subway were removed and the present high speed and frequent headway schedule of trains were maintained, it would not be an hour before the subway would be filled with wrecks from end to end; it would be a charnel house entombing thousands of dead, while the roof would be rent asunder by the shriekings and wailings of the imprisoned, maimed and dying victims of wrecks and burning.

6. Robinson's automatic signal system has increased the traffic capacity of the New York Subway at least three-fold, and probably twice that. Without it the subway equipment could not transport with safety, one-fourth the number of passengers now carried.

7. This invention has created a practically new industry, giving employment to many thousands of men, in various capacities, skilled and unskilled.

8. It is enriching the railroads by enabling them to carry on twice the traffic, with a given equipment, that they could ever do before, and also by saving their equipment from destruction

by collisions and other destructive means, and in saving them from being mulcted in damages for killing and maiming the traveling public.

9. The Robinson automatic system is admittedly the only signal system ever produced that meets all the requirements of safe and rapid railroading.

10. Robinson's subsidiary invention of the rail bond, made more than thirty years ago in connection with his automatic system of signaling, and now in universal use on all electric roads using the track return, throughout the world, has made possible electric railroading as practiced today. Without this Robinson bond or its equivalent those electric roads using the track return could not be operated.

11. The Robinson automatic system is a humanitarian invention of the very highest order, to which thousands of travelers by rail are indebted for the preservation of life and limb.

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